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# Cost and Schedule Report Luminosity Projection

September 8, 2004  
Jeff Spalding

# Methodology

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- The Plan: MS Project file maintained in Welcom Home repository
- Monthly Reports:
  - Progress - % complete from L2/L3 managers using MSP
  - Effort - from each Division (to be consolidated)
  - Actual cost - from lab accounting system, currently via Excel
- Developing new cost reporting
  - Difficulty in current system reporting across Divisions (esp labor)
  - Developed new WBS structure directly linked to cost codes to allow cross-division roll-up
  - Required a major re-organization of WBS and cost codes (complete)
  - Developing new tools for consolidating reporting (using Cobra)
- E-cool installation AIP
  - Installation of electron cooling in the Recycler is now an AIP (Accelerator Improvement Project) with its own reporting, but remains embedded in the Run II Plan
- Additional help
  - Ken Domann, Jeff Sims (AIP) in project office
  - Dixon Bogert and Ann Nestander developing tools

# Status Report

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- Monthly status and report cycle
  - Milestones
  - Progress: %complete and highlights/issues from L2/L3
  - Effort Report
  - M&S Cost Report
- Present report at PMG and send a summary to DOE
- Currently in mid-statusing for end of August
- Data here is for the end of July status report
- Changes > threshold require Change Request document, presented at PMG and signed by Assoc Director
- CR required for release of contingency

# Change Control

Change control thresholds from  
"Management Procedures For the Run II Upgrades", appendix to  
"The Run II Luminosity Upgrade", V2 sent to DOE Jan 04

Run II Luminosity Upgrade Change Control Thresholds	Fermilab Director, Run II Accelerator PMG	Run II Upgrade Project Manager
<b>Technical</b>	Changes that affect ES&H requirements. Out-of-scope changes to upgrade collider capabilities or impact accelerator systems.	Changes that do not affect ES&H requirements and do not affect upgrade scope.
<b>Cost</b>	Any increase by \$ 100 K or assignment of contingency of \$ 100 K to upgrade.	Draw on contingency up to assigned \$ 100 K level (cumulative).
<b>Schedule</b>	Any change in the upgrade critical path or a primary milestone by more than 1 month.	Any change in a critical path for a sub-system or a lower level milestone by more than 1 month.
<b>Personnel</b>	Any increase in required FNAL personnel of 10 % relative to the Resource-Loaded Schedule.	Any change in Level 2 subproject personnel of 10% for the year.

# All Milestones: Feb04 - Feb05

ID	WBS	Name	MS Class	Start	2005											
					Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
776	1.3.5.2.1.1	Pelletron extension parts received	C	3/1/04	■											
1428	1.6.5.2	Review Recycler Commissioning Plan	A	3/1/04	■											
1125	1.4.5.4.3.1.1.1.2	Core electronics PO complete	C	3/11/04	■											
744	1.3.4.3.9	Stacking Performance with 100E10	C	3/15/04	■											
746	1.3.4.3.11	Equilibrium Properties at 200 E10	C	4/5/04		■										
1500	2.2.4.2.2	Review BLM-Abort upgrade Specifications	C	4/19/04			■									
300	1.2.2.3.1.1.2	Decision to Proceed with AP2 BPM DAQ Upgrade	C	4/20/04				■								
427	1.3.3.1.1.5	Review System Design: stacktail momentum (Milestone)	C	4/26/04					■							
748	1.3.4.3.13	Recycler Rapid Transfer Commissioned	C	4/26/04						■						
957	1.3.6.7.3	Review 8Gev energy match plan	C	5/5/04							■					
1003	1.4.2.2.2	BBC: Wires - Report Review	C	5/10/04								■				
752	1.3.4.3.17	Recycler commissioned for Electron cooling	A	6/1/04									■			
68	1.1.1.2.1.23	Slip Stacking HLRF order deliveries 50%	C	6/2/04										■		
767	1.3.5.1.11	Demonstrate beam properties at Wide Band Lab (Milest	C	6/15/04											■	
1089	1.4.5.4.1.1.6	Electronics design review complete	C	8/6/04												○
1127	1.4.5.4.3.1.1.1.4	Core electronics 1st modified board delivered	C	8/9/04												○
1429	1.6.5.3	Review Recycler+E-Cooling Commissioning & Integration	C	8/10/04												○
750	1.3.4.3.15	Extraction Commissioned	C	8/19/04												○
146	1.1.4.4	Booster-MI Cogging Operational	C	8/20/04												○
1175	1.4.5.4.4.1.3	First production quality crate Installation Begins	C	8/23/04												○
1395	1.5.3	Start Summer 04 Shutdown	C	8/23/04												○
452	1.3.3.1.3.2.1.4	Pickup array design finalized	C	8/31/04												○
457	1.3.3.1.3.2.2.4	Kicker array design finalized	C	8/31/04												○
214	1.2.1.1.2.1	Decision on long lithium lens (Milestone)	C	9/15/04												○
222	1.2.1.2.1.5	Prototype Lens 1: Completed (Milestone)	C	9/15/04												○
398	1.2.2.7.4	Decision to proceed with development of chromatic com	C	9/20/04												○
1129	1.4.5.4.3.1.1.1.6	Core electronics 1st production board available	C	10/6/04												○
1554	2.2.4.3.6.2	Decision on 6U Crate	C	10/12/04												○
973	1.4.2.1.1.3	Review TEL R&D	C	10/18/04												○
1195	1.4.5.4.5.1.4	Tev BPM Electronics commissioning complete	C	10/19/04												○
118	1.1.2.2.4.2	Beam Sweeping Ready (redefined)	A	10/21/04												○
76	1.1.1.2.2.6	MLRF upgrade complete	C	10/22/04												○
69	1.1.1.2.1.24	HLRF Upgrade complete	C	11/1/04												○
410	1.2.2.10	Initial AP2&DB Improvements Complete (Milestone)	A	11/19/04												○
1396	1.5.4	Finish Summer 04 Shutdown	C	11/19/04												○
446	1.3.3.1.3.1.2.3	Kicker tank design finalized	C	12/3/04												○
1032	1.4.3.4.3	New standard separators operational	A	12/16/04												○
126	1.1.3.2.1.2	MI BPM: Review (Milestone)	C	12/22/04												○
78	1.1.1.4	Slip Stacking Operational	A	12/23/04												○
1430	1.6.5.4	Start Phase 2 (Milestone)	A	12/23/04												○
1016	1.4.3.2.6	Polarity switches operational	C	12/30/04												○
1338	1.4.5.5.3.2.6	IPM Operational	C	1/5/05												○
1036	1.4.3.5.2	Decision to proceed with mini separators	C	1/12/05												○
442	1.3.3.1.3.1.1.7	Pickup tank design finalized	C	1/21/05												○
1183	1.4.5.4.4.2.2	Frontend Integration Test Complete	C	1/28/05												○
141	1.1.3.3.5	MI 2.5 MHz Acceleration complete	B	1/31/05												○

All milestones  
are on track

○ = complete in August

cogging operational, but needs  
improved PS

Stacktail upgrade loop design  
defined

Slip Stacking and Start of  
Phase 2 on track

expect to make decision  
on mini-separators by Oct

# Progress

Planned work @39%, L2.5 managers report 38% (v3 baseline)

WBS		TEC (incl G&A)	Actual % BCWP/TEC	Plan'd % BCWS/TEC	A/P %
	<b>Run II Upgrades</b>	<b>\$48,257,282</b>	<b>38%</b>	<b>39%</b>	<b>97%</b>
<b>1</b>	<b>Luminosity Upgrades</b>	<b>\$40,629,308</b>	<b>40%</b>	<b>42%</b>	<b>97%</b>
<b>1.1</b>	<b>Protons on Pbar Target</b>	<b>\$4,192,894</b>	<b>51%</b>	<b>52%</b>	<b>98%</b>
1.1.1	Slip Stacking	\$1,648,489	94%	96%	98%
1.1.2	Pbar Target & Sweeping	\$239,111	86%	85%	100%
1.1.3	MI Upgrades	\$1,903,045	12%	12%	95%
1.1.4	Booster-MI Cogging	\$74,850	98%	98%	101%
1.1.5	Optical Transition Radiation Detectors	\$327,398	26%	25%	105%
<b>1.2</b>	<b>Pbar Acceptance</b>	<b>\$4,596,631</b>	<b>33%</b>	<b>36%</b>	<b>89%</b>
1.2.1	Lithium Lens Upgrades	\$1,350,884	35%	36%	99%
1.2.2	AP2 & Debuncher Acceptance	\$3,245,747	31%	37%	85%
<b>1.3</b>	<b>Pbar Stacking &amp; Cooling</b>	<b>\$10,421,044</b>	<b>47%</b>	<b>49%</b>	<b>97%</b>
1.3.1	Stacking & Cooling Integration	\$414,491	70%	73%	96%
1.3.2	Debuncher Cooling	\$30,078	100%	100%	100%
1.3.3	Stacktail Cooling	\$2,261,809	5%	8%	62%
1.3.4	Recycler Stacking & Cooling	\$1,866,541	85%	86%	99%
1.3.5	Electron Cooling	\$4,466,748	60%	60%	101%
1.3.6	Rapid Transfers	\$1,381,376	15%	20%	71%
<b>1.4</b>	<b>Tevatron High Luminosity</b>	<b>\$19,295,445</b>	<b>36%</b>	<b>37%</b>	<b>97%</b>
1.4.1	Beam Studies and Simulation	\$3,268,676	40%	40%	100%*
1.4.2	Active Beam-Beam Compensation	\$3,250,776	11%	13%	87%
1.4.3	Increased Helix Separation	\$4,442,218	27%	28%	98%
1.4.4	Luminosity Leveling	\$13,241	0%	0%	
1.4.5	Improved Control & Diagnostics	\$6,355,721	48%	50%	96%
1.4.6	Tevatron Vacuum Improvements	\$126,162	40%	34%	119%
1.4.7	Tevatron Alignment	\$1,838,651	53%	52%	101%
<b>1.6</b>	<b>Project Management - Jeff Spalding</b>	<b>\$2,123,295</b>	<b>43%</b>	<b>43%</b>	<b>100%*</b>
<b>2</b>	<b>Maintenance &amp; Reliability</b>	<b>\$7,627,973</b>	<b>28%</b>	<b>27%</b>	<b>102%</b>

behind on long-term study plan

design work just started  
expected to catch up

behind on BPM upgrade,  
hall probes -added people

TEL R&D behind in  
studies and hardware  
Review sched for Oct

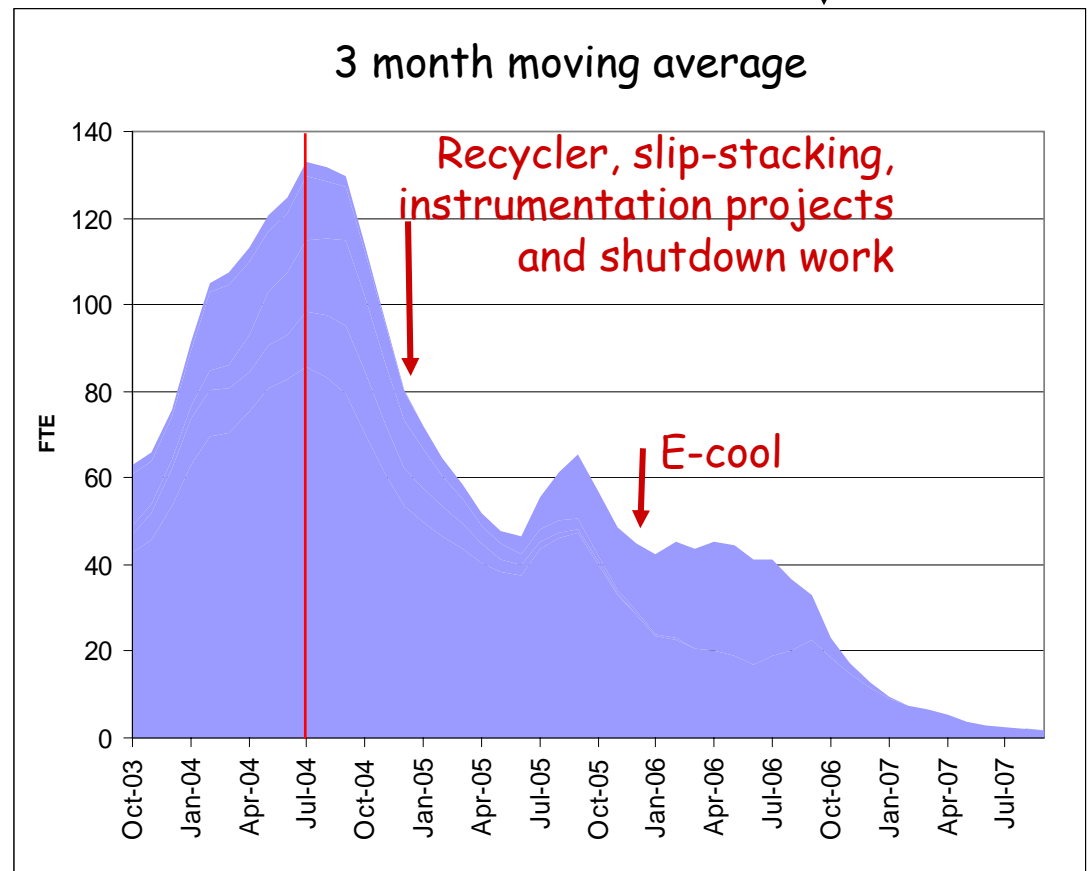
\* pro-rated

# Labor Profile

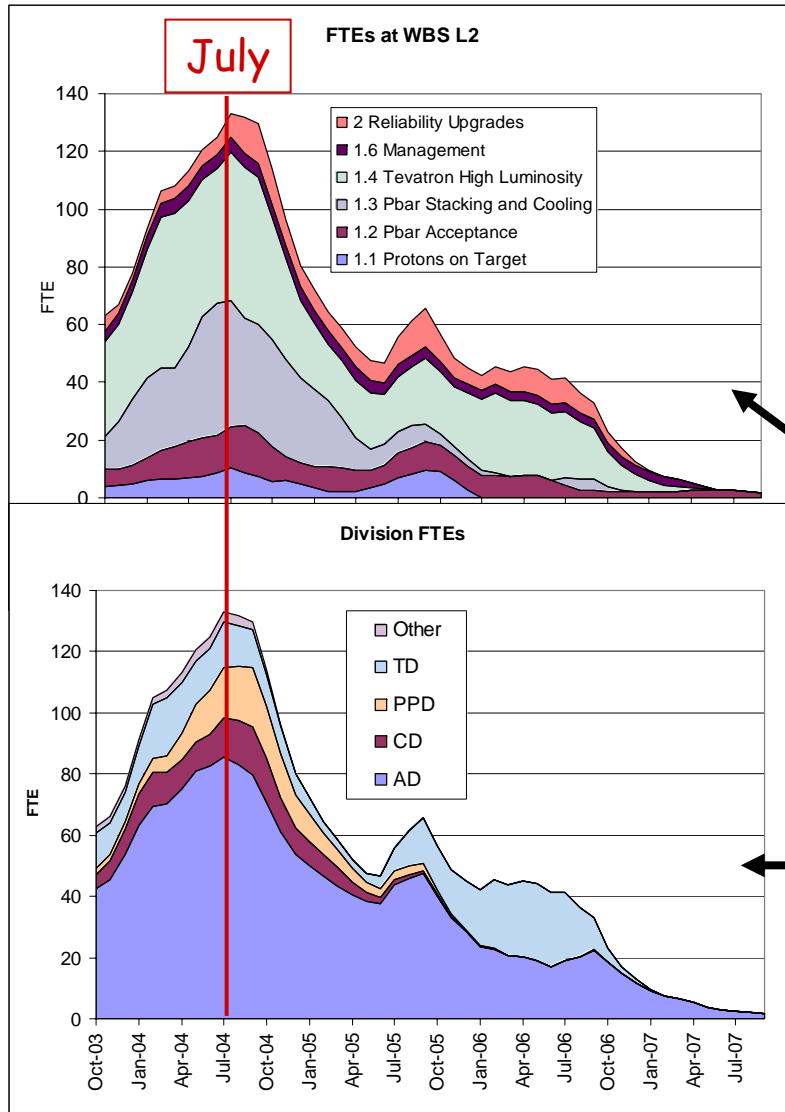
Estimated base labor profile in FTE from RLS (FTE=work/0.85)

Notes:

- Base profile is w/o labor contingency = schedule contingency
  - phase milestone contingency allows stretch ~ 3 months by end 04 and 6 months by end 06
- Labor falls off as subprojects complete
- "Completion" = commissioned to the point that the system is put into HEP operation - optimization may continue for many more months (a learning slope in the luminosity projection)



# Labor: Estimate vs Actual



- Est profile in FTE from RLS
- Actual FTE reported each month
- Compare for July:  
est need = 133, actual = 128

FTE	Jul-04	
	Actual	RLS Est
<b>Total</b>	<b>128.4</b>	<b>133.2</b>
<b>Breakdown at WBS L2</b>		
1.1 Protons on Target	18.4	10.2
1.2 Pbar Acceptance	10.9	14.5
1.3 Pbar Stacking and Cooling	39.2	43.5
1.4 Tevatron High Luminosity	48.8	51.6
1.6 Management	3.9	5.2
2 Reliability Upgrades	7.3	8.2
<b>Breakdown by Division</b>		
AD	83.9	85.6
TD	13.0	12.7
PPD	16.2	16.7
CD	12.2	14.7
non-FNAL	2.9	3.6



# M&S Cost Report (July)

FY04 base estimate 87% obligated, total 47% obligated

	RLS Estimate (then yr\$)				FY04 Obl+RIP	Obl+RIP /FY04 Est	Obl+RIP /Total Est
	FY04	FY05	FY06	Total			
<b>Run II Upgrades</b>	<b>9,418</b>	<b>6,253</b>	<b>1,778</b>	<b>17,448</b>	<b>8,152</b>	<b>87%</b>	<b>47%</b>
<b>1 Luminosity Upgrades</b>	<b>7,799</b>	<b>4,689</b>	<b>650</b>	<b>13,138</b>	<b>6,578</b>	<b>84%</b>	<b>50%</b>
<b>1.1 Protons on Target</b>	<b>656</b>	<b>961</b>	<b>2</b>	<b>1,619</b>	<b>423</b>	<b>64%</b>	<b>26%</b>
1.1.1 Slip Stacking	416	0	0	416	364	88%	88%
1.1.2 Pbar Target and Sweeping	42	11	2	54	15	34%	27%
1.1.3 MI Upgrades	26	950	0	976	0	0%	0%
1.1.4 Booster-MI Cogging	0	0	0	0	0	0%	0%
1.1.5 OTR	172	0	0	172	44	26%	26%
<b>1.2 pbar Acceptance</b>	<b>503</b>	<b>441</b>	<b>433</b>	<b>1,378</b>	<b>371</b>	<b>74%</b>	<b>27%</b>
1.2.1 LiLens	133	179	108	421	102	77%	24%
1.2.2 AP2 and DB Acceptance	370	262	325	957	269	73%	28%
<b>1.3 pbar Stacking and Cooling</b>	<b>3,027</b>	<b>821</b>	<b>0</b>	<b>3,848</b>	<b>2,286</b>	<b>76%</b>	<b>59%</b>
1.3.1 S&C Task Force	0	0	0	0	0	0%	0%
1.3.2 Debuncher Cooling	0	0	0	0	0	0%	0%
1.3.3 Stacktail Upgrade	933	503	0	1,436	692	74%	48%
1.3.4 Recycler Commissioning	257	0	0	257	203	79%	79%
1.3.5 Electron Cooling	1,511	86	0	1,597	1,339	89%	84%
1.3.6 Rapid Transfers	325	233	0	558	51	16%	9%
<b>1.4 Tevatron High Luminosity</b>	<b>3,523</b>	<b>2,463</b>	<b>215</b>	<b>6,201</b>	<b>3,399</b>	<b>96%</b>	<b>55%</b>
1.4.1 Beam Studies and Simulation	38	0	0	38	38	101%	101%
1.4.2 Active BBC	365	800	123	1,288	436	119%	34%
1.4.3 Increased Helix Separation	740	1,485	76	2,301	748	101%	33%
1.4.4 Luminosity Leveling	0	0	0	0	0	0%	0%
1.4.5 Improved Controls and Diagnostics	2,113	29	0	2,142	1,835	87%	86%
1.4.6 Tevatron Vacuum Improvements	154	0	0	154	183	118%	118%
1.4.7 Tevatron Alignment	114	148	16	278	159	139%	57%
<b>1.6 Management</b>	<b>93</b>	<b>0</b>	<b>0</b>	<b>93</b>	<b>99</b>	<b>107%</b>	<b>107%</b>
<b>2 Reliability Upgrades</b>	<b>1,619</b>	<b>1,564</b>	<b>1,128</b>	<b>4,310</b>	<b>1,574</b>	<b>97%</b>	<b>37%</b>
2.1 Vulnerability White Paper	797	813	1,126	2,736	801	100%	29%
2.2 Reliability Upgrades	821	751	2	1,574	773	94%	49%

## M&S Guidance and Contingency

- Budget guidance including contingency = \$22,087K FY04-06
- Contingency is held by Fermilab Directorate and released via Change Request process
- Currently 50% contingency on estimate to complete (obligations)

M&S in Then Yr \$K	FY04	FY05	FY06	Total	Avail Cont
Budget Guidance	14,188	4,894	3,005	22,087	4,639
V3 Estimated Base	9,418	6,253	1,778	17,448	
Est. To Complete	1,266	6,253	1,778	9,296	50%

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## V3 Luminosity Projection

# Luminosity Projection

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Our plan is to deliver the Design Projection  
also develop an understanding of fallback scenarios

In v3, mixed-source operation and the phased stacktail upgrade allow more natural introduction of key upgrades (e-cooling and Stacktail upgrades) and provide a more robust fall-back position

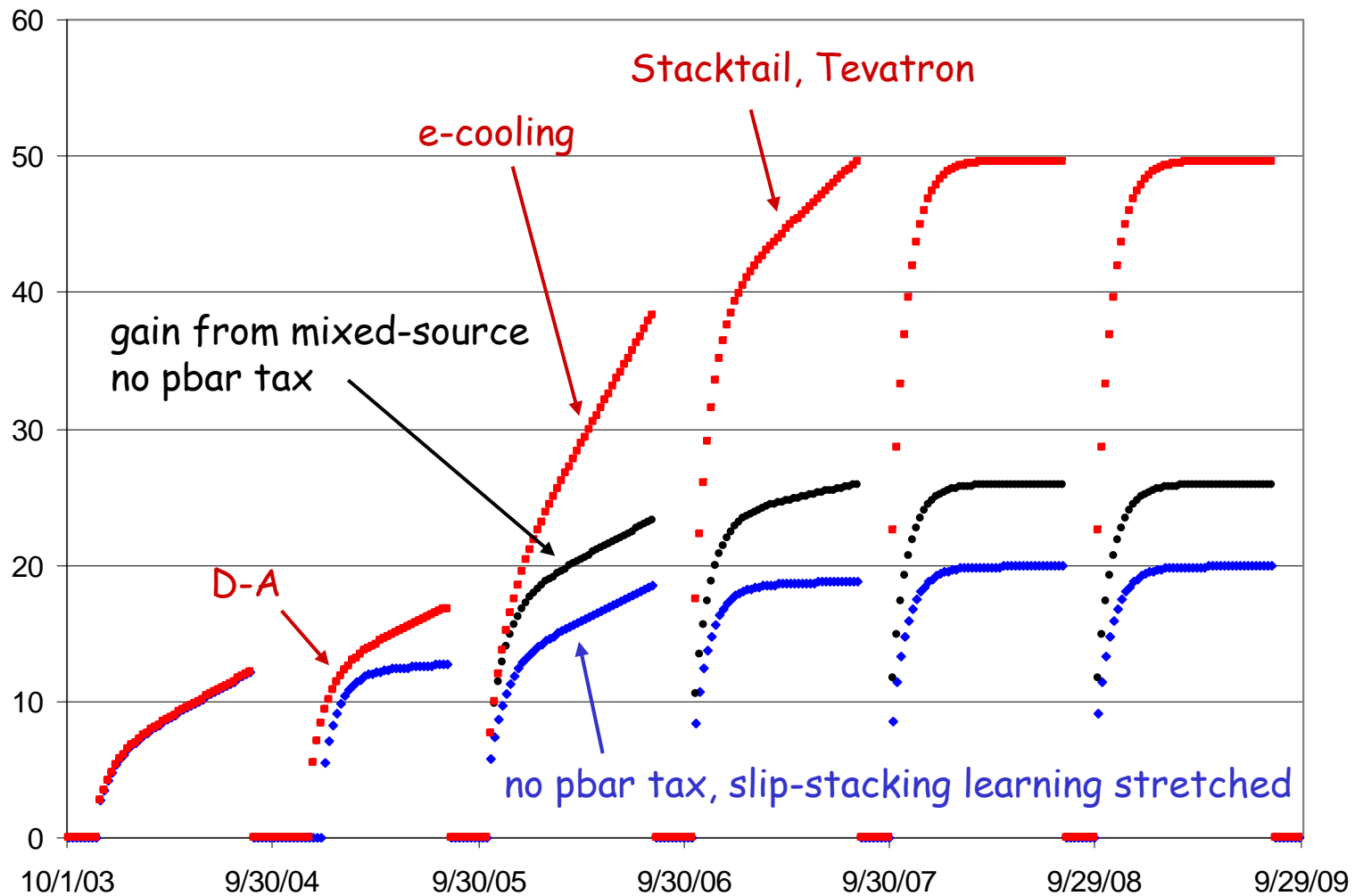
## Three Curves

- Design Projection: electron cooling and Stacktail upgrade
- Black Projection: no electron cooling, mixed-source operation beyond 05 (20% gain), Deb→Acc acceptance solved
- Blue Projection: no electron cooling, Deb-Acc acceptance only minor improvements and no gain from mixed-source

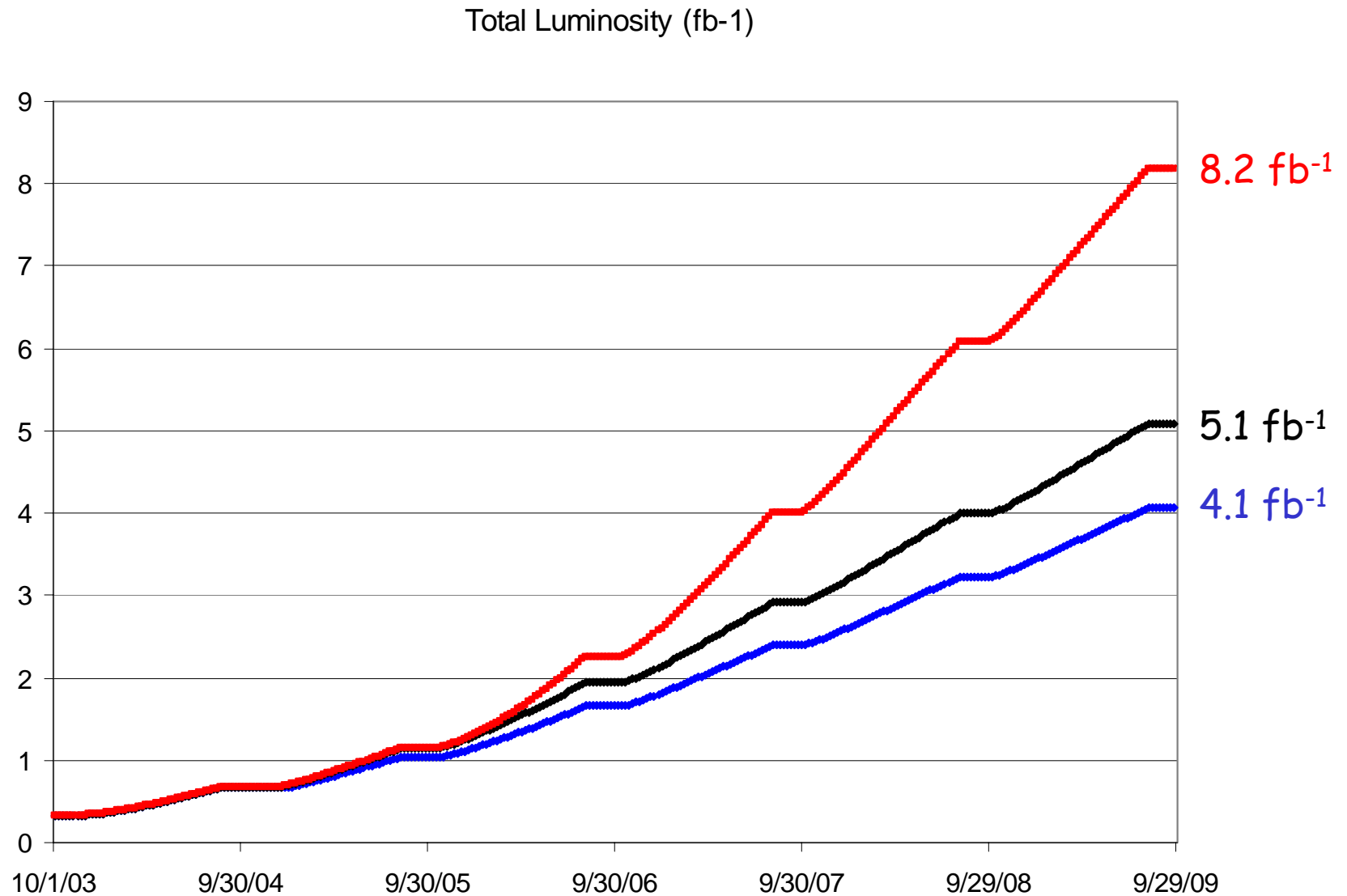
All assume slip stacking and 100 HEP hrs per week average long-term

# Weekly Luminosity

Integrated Weekly Luminosity (pb-1)



# Integrated Luminosity



# Parameters: Design Curve

Phase	1	2	3	4_5	6	
Parameter	FY04 Plan	Slip Stacking	Recycler Ecool + Stacktail tank move	Stacktail + Helix	Reliability	Units
Initial Luminosity	77	96	219	284	284	$\times 10^{30} \text{ cm}^{-2} \text{ sec}^{-1}$
Integrated Luminosity per week	12	17	38	50	50	$\text{pb}^{-1}$
Average Store Hours per Week	100	100	100	100	100	Hours
Store Length	25	20	20	15	15	Hours
Number of Protons per bunch	250	260	260	270	270	$\times 10^9$
Number of Pbars per bunch	33	42	99	131	131	$\times 10^9$
Zero Stack Stacking Rate	13	24	30	46	46	$\times 10^{10}/\text{hour}$
Average Stacking Rate	6	10	22	39	39	$\times 10^{10}/\text{hour}$
Stack Size transferred	158	201	447	589	589	$\times 10^{10}$
Pbar Production	16	17	21	32	32	$\times 10^{-6}$
Protons on Target	5.4	8	8	8	8	$\times 10^{12}$
Pbar cycle time	2.4	2	2	2	2	Secs.
Pbar up time fraction	0.75	0.75	1	1	1	
A->R Transfer interval			2.5	0.5	0.5	Hours
A->R Transfer efficiency			90	98	98	%
A->R Transfer Time			0.2	0.05	0.05	Hours

average

merge

e-cool

# Parameters in FY09

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## Design

e-cooling  
and stacktail upgrade

- Slip stacking at  $8 \times 10^{12}$  ppp
- Deb & AP2 at  $32\pi$ -mm-mrad
- Av. Stk rate =  $39 \times 10^{10}$ /hr
- Stk in Accum =  $20 \times 10^{10}$
- Stk from Rec'r =  $590 \times 10^{10}$

## Black

no e-cool  
nor stacktail upgrade  
gain from mixed-source  
D-A solved

- Slip stacking at  $8 \times 10^{12}$
- Debuncher & AP2 at  $17\pi$
- Av. Stk rate =  $13 \times 10^{10}$
- Stk in Accum =  $200 \times 10^{10}$
- Stk from Rec'r =  $123 \times 10^{10}$

## Blue

no e-cool  
nor stacktai upgrade  
no gain from mixed-source  
D-A only minor improvements

- Slip stacking at  $7 \times 10^{12}$
- Debuncher & AP2 at  $17\pi$
- Av. Stk rate =  $9 \times 10^{10}$
- Stk in Accum =  $183 \times 10^{10}$
- Stk from Rec'r =  $0 \times 10^{10}$



don't need increase in AP2 & DB admittance



## Summary

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- Status report versus v3
  - On-track for all milestones
  - Labor resources ~ estimated need
  - Available contingency allows addition of instrumentation projects (OTR, BLM)
- The upgrade projects are making good technical progress
- V3 has schedule slip in e-cooling (nevertheless technical progress is very good)
- Compensate with phased plan for stacktail upgrade
- The design projection is still  $>8 \text{ fb}^{-1}$  for 2009
- New phasing along with improved reliability and mixed-source operation make the fall-back scenarios more robust,  $>4 \text{ fb}^{-1}$